Physics Flash

December 2018
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INSIDE

Los Alamos NATIONAL LABORATORY EST. 1943

Mandie Gehring calibrates a Compton spectrometer, located at the Los Alamos Neutron Science Center, that is being used for x-ray spectral measurements.

Mandie Gehring

Dispatching diagnostics and data for national security needs

By H. Kris Fronzak

As a research scientist and team leader in Neutron Science and Technology (P-23), Mandie Gehring specializes in perfecting instrumentation and assessing data for radiography experiments performed at Los Alamos National Laboratory and elsewhere.

Mandie Gehring likes to go fast. She is a lifelong roller coaster enthusiast who grew up wanting to serve the nation as an Air Force fighter pilot. But when Gehring learned her height and eyesight disqualified her from flying in the armed forces, she charted those passions toward imaging high-velocity explosions for national security science.

As a research scientist and team leader in Neutron Science and Technology (P-23), Gehring specializes in perfecting instrumentation and assessing data for radiography experiments performed at Los Alamos National Laboratory and elsewhere. Pulsed radiography uses x-ray bursts to image dynamic motion. Gehring tests materials via radiography that are often key to qualifying the nation's nuclear stockpile.

One of her earliest contributions to the Lab's national security mission was when, as a postdoctoral researcher, she constructed and calibrated a spectrometer that measured

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From David's desk . . .

"As this is the last Physics Flash of 2018, I hope that all of you have a wonderful and safe holiday season and are able to relax, rejuvenate, and enjoy time with family and friends. We have a lot to deliver in 2019 and I know that you are up to the challenge."

The contract transition has come and gone. The name of our associate level directorate (ALD) has changed to Physical Sciences. There are a few new faces above us, and the ALD has added a couple of divisions. I hope that you will not be significantly impacted by these changes. I welcome Toni Taylor and Raeanna Sharp-Geiger and thank Mary Hockaday for her previous leadership of Experimental Physical Sciences.

The clocks have changed, but our mission and deliverables have not. My expectations of Physics having a professional working environment has not changed. My view that this is a wonderful division to lead has not changed.

The other big change is the appointment of Eric Pitcher as deputy division leader. I am looking forward to working with Eric. Eric will spend half his time as LANL's advanced experimental capability director. In this role, he will support capability development across the Lab. This will include Pu@pRad, convincing the Office of Fusion Energy Sciences to develop a Los Alamos Fusion Materials Irradiation Facility (LAFMIF) at Area A, and, in the future, developing the experimental hall for a future x-ray free electron laser on the TA-53 mesa (a project formerly known as MaRIE). I know this was a long process, but I think that I have the right person to help me move the division forward. Thanks for your patience. Julie Canepa will continue to provide support to P-DO. I am looking forward to having more time to work on strategic planning for the division. Please also welcome Tom Venhaus as a new P-21 deputy group leader.

We will need to continue our furious hiring pace. We have 37 FY19 hires in our staffing plan, not including postdocs. I worry that the balance between the number of mentors and mentees will make traditional one-on-one mentoring challenging. I worked with Ellen Cerreta and Stacey Eaton on a small study on mentoring for Nan Sauer. I have started an experiment on what I call "team mentoring." I chose three mentors and six early-career staff from a list of volunteers to meet monthly to discuss career planning, how to manage at LANL, etc. My selections were focused on diversity, including having the nine from different teams and groups. I expect to meet with the team in a couple of months to assess this experiment. If it looks promising, I will set up other teams, possibly including other divisions within the directorate. There will be an article on it in the next *Physics Flash*.

I am very excited that the work done in Physics Division continues to be recognized by internal and external awards. We had four 2017 LANL Distinguished Performance Awards, six NNSA Defense Program Awards of Excellence, and a 2018 Pollution Prevention Award, as described in this issue. Recently, we were notified that Elena Guardincerri, Matt Durham, and Chris Morris were part of an MSTS-led team that received a 2018 R&D 100 award for "Silicon Strip Cosmic Muon Detectors for Homeland Security." Congratulations to all!

As this is the last *Physics Flash* of 2018, I hope that all of you have a wonderful and safe holiday season and are able to relax, rejuvenate, and enjoy time with family and friends. We have a lot to deliver in 2019 and I know that you are up to the challenge.

Physics Division Leader David Meyerhofer

Gehring cont.

high-energy x-rays using Compton scattering (see "Mandie Gehring's favorite experiment" below).

The dedication and depth of expertise Gehring showed in constructing the spectrometer led her to become principal investigator (PI) of radiography for Vega, an experimental shot at the Nevada National Security Site. Vega was the final shot in the years-long Lyra series, which studied the physics behind shock-driven plutonium. As the radiography PI, Gehring spent hours investigating different detector schemes and optimizing the system to take sharper images.

"Subcritical experiments are a big deal in general, but because Vega was the first plutonium subcritical experiment that we'd done [in the United States] in five years, it made Mandie's work an even bigger responsibility," said her former mentor Todd Haines (P-23). "Mandie quickly made it obvious that she knew what to do—we still can't believe how great these images are."

"Vega was a lot of pressure, and it was sometimes strange to give orders to people twice my age, but I had an amazing team behind me," said Gehring, who earned her Ph.D. in chemistry from Michigan State University in 2013 and joined Los Alamos as a postdoctoral researcher later that year.

She has continued to distinguish herself since becoming a Lab staff member. This year she was part of a team that won two NNSA Defense Programs Awards of Excellence: one for Vega and another for the Brazos project, which developed a pulsed neutron source. She was named leader of P-23's National Security Science Team in June and is the PI of radiography for the future Red Sage series, which is being led by Los Alamos researchers to better measure ejecta from plutonium.

She is part of a Laboratory Directed Research and Development project that pairs experiments with simulation to develop a material for more resilient radiation detectors. For this machine-learning project, Gehring will return to her roots in chemistry and synthesize materials making it faster and easier to discover and perfect future radiation detector materials.

"Mandie has expertise in both synthesis and characterization, so her main role will be to bridge these two approaches," said Blas Uberuaga (Materials Science in Radiation and Dynamics Extremes, MST-8), the project's PI. "Ultimately, we plan to create a feedback loop where simulations tell us what to create, which then helps us improve the simulations, and so on. Mandie will help close that loop by making sure we're developing materials that can be meaningfully characterized."

The resulting capability will benefit global security, the medical imaging field, and Enhanced Capabilities for Subcritical Experiments, which is the next major radiographic facility planned in the United States.

"The different problems the stockpile faces in the future will require far more projects like this one, which integrates models with traditional experiments," Gehring said. "I'm very excited to return to a chemistry lab, and I hope to contribute to the development of synthesis methods for these new, inorganic materials."

Mandie Gehring's favorite experiment

What: Measuring the x-ray spectrum of the Cygnus sources

Why: The purpose is to assess shot-to-shot variability, which provides insight into machine performance and assists in density reconstructions.

When: August 2016

Where: U1a Complex at the Nevada National Security Site

Who: Michelle Espy and I ran the experiment with support from the U1a crew, especially Nichelle Prock and Russ Howe.

How: We fielded a Compton spectrometer, which was specifically designed for this experiment, about 1.2 meters from the Cygnus machines. Ideally, we would have been much closer, which would have increased the signal level. I optimistically expected that we'd see *something*, even if the signal level was too low to discern a proper spectrum, but Michelle was more skeptical.

The "a-ha" moment: I don't recall a successful measurement on the first try—I think we had to improve our collimation and make a couple of other tweaks to our setup—but within a few days we took a shot where we had clear signal. It was better than I had hoped! We were able to measure the full spectrum, though it was quite noisy. In the future, we hope to measure it from a better, closer location.

Physics Division staff in the news

Distinguished Performance Awards recognize notable contributions to Lab's mission

Thirteen members of Physics Division received 2017 Los Alamos National Laboratory Distinguished Performance Awards, acknowledging their outstanding contributions to the Laboratory's mission.

Individual award
Patrick Younk

Patrick Younk (Neutron Science and Technology, P-23) led the implementation of a new measurement technique, broadband laser ranging (BLR), for measuring the dynamics of pit implosion. Younk's accomplishments mean that BLR will be an enduring and important new component of stockpile stewardship, helping to keep Los Alamos at the forefront of optical diagnostics for the weapons program.

Small team award
High-Resolution Spectrometer Removal Team

This team, which included Walter Sondheim and Jason Medina (Subatomic Physics, P-25), was tasked with removing the obsolete, 600-ton, multistory high-resolution spectrometer from the Los Alamos Neutron Science Center (LANSCE) to make way for dynamic plutonium experiments at the Proton Radiography Facility. Such experiments will be a unique capability within the DOE complex.

Other team members were Julie Maze (ASM Project Procurement, ASM-PROJPR); Effiok Etuk (Engineering Services LANSCE Facility Operations, ES-LFO); and John Ainsworth and Michael Gonzales (Construction Superintendents, MOF-CM-CS).

Large team awards
Brazos Intense Short-Pulse Photoneutron Source Demonstration Team

Neutron-diagnosed subcritical experiments (NDSEs) are a high priority for the Laboratory's experimental weapons physics program. This team, which included Neutron Science and Technology (P-23) and Plasma Physics (P-24) members, demonstrated a successful method for producing the needed neutron pulse. This team's success resulted in a proposal to use an upgraded Cygnus machine for the first NDSE series and for further NSDEs throughout the 2020s.

Team members were Dana Duke, Todd Haines, Melissa Boswell, Mandie Gehring, and Brandon White (P-23); Thomas Archuleta, Hans Herrmann, Yong Ho Kim, and Kevin Meaney (P-24); Michelle Espy (Non-Destructive Testing & Evaluation, AET-6); Christopher Johnson (Advanced Nuclear Technology, NEN-2); and Michael McCumber (Monte Carlo Codes, XCP-3).

Nuclear Explosive Package Team

The team, assisted by Ron Nelson (LANSCE Weapons Physics, P-27), addressed a complex, open-ended stockpile aging problem that was poorly constrained by inspection data. Team members designed and performed experiments, developed material models, and produced a computer code to model this aging process, delivering the code in 2017.

Other team members were from Non-Destructive Testing & Evaluation (AET-6), Bioenergy and Biome Sciences (B-11), Chemical Diagnostics and Engineering (C-CDE), Inorganic Isotope and Actinide Chemistry (C-IIAC), Materials Synthesis and Integrated Devices (MPA-11), Fabrication Manufacturing Science (Sigma-1), Finishing Manufacturing Science (Sigma-2), Physics and Chemistry of Materials (T-1), Physics of Condensed Matter and Complex Systems (T-4), Surveillance Oversight (W-9), Advanced Engineering Analysis (W-13), Weapon Systems Division Office (W-DO), and XCP-3.

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Dallmann, Morris, Nath inducted into Lab's Innovation Honor Society

Nicholas Dallmann, Pulak Nath (both Applied Modern Physics, P-21) and Christopher Morris (Subatomic Physics, P-25) have been named to the inaugural class of the Los Alamos Innovation Honor Society.

Created by the Richard P. Feynman Center for Innovation, the society recognizes outstanding Los Alamos technical staff who have made long-standing contributions to scientific discovery, innovation, and technology transfer. Selection is based on collaborations, protection and deployment of innovation assets, and other considerations such as intellectual property inventions, copyrights, and technology transfer efforts.

Dallmann's technical focus is CubeSats—small, low-cost satellites that provide scientists with an easy way to access space. His primary partner is a Laboratory mission sponsor. Dallmann has 505 citations and is a member of P-21's Quantum Key Communication team.

Morris's technical focus is muon radiography and tomography. His primary partners are Decision Sciences, TEPCO, and Toshiba. Morris has authored more than 300 papers in refereed journals, given more than 200 invited talks, and received 12 patents and 3 R&D 100 Awards.

Nath's technical focus is microfluidics and miniaturization. His primary partners are STD Quick Screen, Vista Therapeutics, Divine Beauty, Pivotal Biotech, Microwave Biostimulation, CFD Research Corp., and ATHENA. Nath received an R&D 100 Award for his work on the Pulmonary Lung Model and he has 10 patent applications.

Other Laboratory inductees were Dipen Sinha and Cristian Pantea (Materials Synthesis and Integrated Devices, MPA-11), Bette Korber and Peter Hraber (Theoretical Biology and Biophysics, T-6), Gary Grider (High Performance Computing, HPC-DO), Stephen Judd (X Theoretical Design, XTD-DO), and Patrick Chain (Biosecurity & Public Health, B-10).

Technical contacts: Nicholas Dallmann, Christopher Morris, Pulak Nath

Da Silva receives RHIC/AGS User's Executive Committee merit award

Cesar Luiz da Silva (Subatomic Physics, P-25) has received a RHIC/AGS User's Executive Committee merit award. He was cited "for his intellectual leadership and exceptional contributions to software, electronics, detector development, as well as key heavy-flavor results with the PHENIX experiment." PHENIX is a long-term experiment designed to record different particles emerging from relativistic heavy ion collisions.

The award was announced at the 2018 Relativistic Heavy Ion Collider (RHIC)/Alternating Gradient Synchrotron (AGS) Annual Users' Meeting at Brookhaven National Laboratory.

The award is given to scientists who have received their Ph.D. within the last 10 years and conducted outstanding theoretical or experimental research at key facilities within the Brookhaven National Laboratory complex, including RHIC, AGS, NASA Space Radiation Laboratory, Tandem Van de Graaff, Brookhaven Linac Isotope Production, and the Accelerator Test Facility.

Da Silva, who received a Ph.D. in nuclear physics from the University of Sao Paulo, Brazil, is P-25's High Energy Nuclear Physics team leader. He has organized several conferences in the research field, including multiple RHIC/AGS Annual Users' Meeting workshops on heavy-quark physics; served as the heavy-quark convener for PHENIX, which involved reviewing and guiding heavy-quark-related analysis; and played a key role in leading the upgrade of the Forward Silicon Vertex detector. Da Silva also introduced a new technique that made B meson measurements possible with PHENIX.

Technical contact: Cesar Luiz da Silva

Haffey receives 2018 Distinguished Student Performance Award

Kiersten Haffey (Applied Modern Physics, P-21) received a 2018 Los Alamos Distinguished Student Performance Award. Sponsored by the Student Programs Advisory Committee and the Student Program Office, the awards recognize outstanding performance by Lab students.

Haffey was nominated by Pulak Nath (P-21) for her work on two projects. The first involved developing and character-

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In the news cont.

izing a non-pneumatic elastic membrane actuation platform designed to emulate physiological "breathing" in a miniaturized, tissue-engineered, artificial lung. These engineered lung models are being used in the study of toxicology of biological and chemical threat agents. The work is funded by the Defense Threat Reduction Agency.

After her work on the miniature lung project, Nath gave Haffey the lead on a second project that is part of an Laboratory Directed Research and Development project and involved developing microfluidic traps for single cell applications. She fabricated and characterized the traps.

Both of these projects are leading to publications that feature Haffey as the first author. Haffey was a post-baccalaureate student from the University of Wisconsin–Madison. She is now pursuing a Ph.D. in bioengineering at the University of California, San Diego.

Technical contact: Kiersten Haffey

Physics Division staff recognized with NNSA Defense Programs Awards of Excellence

Physics Division researchers recently received six 2017 NNSA Defense Programs Awards of Excellence in recognition of significant achievements in quality, productivity, cost savings, safety, or creativity in support of NNSA's Stockpile Stewardship Program.

B61 Auxiliary Detonator Down Select team
The team, which included Sky Sjue (Applied Modern Physics, P-21), worked to a create timely and effective resolution that enables the NNSA to meet its schedule for the B61-12 Life Extension Program first production unit. The B61 Aux Detonator was extremely difficult to design due to performance requirements and restrictions. It also required reliable operation in new regimes that were well beyond previous designs.

Plasma Kinetic Physics Team
Researchers—including Yongho Kim and Scott Hsu (Plasma Physics, P-24)—used the Trinity supercomputer to run state-of-the-art kinetic plasma simulations at the multi-petaflop/s scale. The project, completed under the auspices of Los Alamos's Advanced Simulation and Computing Program, substantially enhanced the Laboratory's predictive capability for modeling high-energy-density and inertial fusion plasmas for the Stockpile Stewardship Program and contributed to the national exascale effort. As a result, Los Alamos is now positioned as an international leader in software development on modern supercomputers.

pRad Gun Team
After an eight-year stand down, the proton radiography powder gun has been requalified and is producing high-quality experimental data. The combination of proton radiography and dynamic loading provides for the ability to obtain data that previously had to be inferred or could not be observed. Physics Division researchers were Alexander Saunders, Dale Tupa, Zhaowen Tang, Levi Neukirch, Fesseha Mariam, Chris Morris, Jason Medina, Amy Tainter, Tamsen Schurman, and Julian Lopez (Subatomic Physics, P-25); and Carl Wilde, Fran Trouw, Joshua Tybo, John Goett, Patrick Medina, and Matthew Freeman (Neutron Science and Technology, P-23).

Tri-Lab Tantalum Strength Team
This team, which included Sky Sjue (P-21), used studies from different experimental platforms to evaluate tantalum strength models used in weapon codes. The project included forming a compendium of experimental results, identifying and conducting additional experiments to increase the overlap between different platforms, and beginning to identify potential theoretical gaps.

Vega Subcritical Experiment Team
Vega, the final experiment of the Lyra Subcritical Experiment (SCE) series, was conducted in 2017 at the Nevada National Security Site. The data will support future reuse options and improve the surety of the current stockpile. The Vega SCE team worked closely with the Hazard Category 2 (HC-2) Upgrade team, as this was the first plutonium experiment to be conducted at the U1a complex as an HC-2 nuclear facility.

Physics Division members were Andrea Albert, Matthew Briggs, Dominic Cagliostro, Jeremy Danielson, Anemarie DeYoung, Brenda Dingus, Christen Frankle, Mandie Gehring, John Goett, Todd Haines, Pat Harding, Bob King, Anna Llobet, Ruben Manzanares, Matthew Murray, Jeremy Payton, Peter Pazuchanics, Larry Rodriguez, John Smith, Danny Sorenson, Joshua Tybo, Patrick Younk, and Jacqueline Mirabal-Martinez (P-23); Mitzi Boswell (formerly P-23, now with Nuclear and Radiochemistry [C-NR]); Michael Ham, John Perry, Mark Peters, and Vincent Yuan (P-21); and David Holtkamp, Nick King, Patrick Medina, Andrew Obst, Monty Wood, and Alexine Salazar (P Division).

World's First Intense Warm Photoneutron Source Demonstration
The project to develop a short-pulse photoneutron source using an x-ray source, first proposed in 2017, was performed in an extraordinarily short time. Its success marked the first-ever pulsed photo-neutron production on beryllium

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In the news cont.

experiments. Physics Division members who participated were Todd Haines, Dana Duke, Mandie Gehring, and Brandon White (P-23); Mitzi Boswell (formerly P-23, now with Nuclear and Radiochemistry [C-NR]); Nick Archuleta (P-24); and Yongho Kim and Kevin Daniel Meaney (P-24).

Technical contact: Jon Ventura

Muon technology receives 2018 R&D 100 Award

A device generated from foundational work by Physics Division researchers has received a 2018 R&D 100 Award. Christopher Morris, J. Matthew Durham, and Elena Guardincerri (Subatomic Physics, P-25) helped create and refine the technique of muon scattering radiography, which led to "Silicon Strip Cosmic Muon Detectors for Homeland Security." This device tracks the scattering trajectories of natural cosmic particles called muons, enabling it to detect shielded nuclear materials, explosives, and other items.

Made of silicon strip muon detectors, it is flexible and can be stealthily deployed into walls, ceilings, and portable devices. The invention was jointly submitted by Nevada National Security Site Mission Support and Test Services LLC, Fermi National Accelerator Laboratory, and Los Alamos National Laboratory.

The annual R&D 100 Awards honor the top 100 proven technological advances of the past year as chosen by a panel selected by *R&D Magazine*. The Lab's projects covered energy, modeling and simulation, health, materials, and engineering, and demonstrate the continued success of Laboratory researchers in technical innovation for national security science. Los Alamos has won 145 R&D 100 Awards since 1978. The winners of this year's competition were announced in a ceremony earlier this month.

The work supports the Laboratory's Global Security mission and its Nuclear and Particle Futures science pillar by applying technology and methods used in high-energy particle physics to solve a challenge in international nuclear safeguards.

Technical contact: Elena Guardincerri

Workshop explores Proton Radiography Facility's potential in advancing materials studies

Los Alamos National Laboratory recently held a workshop focused on using its Proton Radiography Facility (pRad) as well as other diagnostics for materials science discoveries at the mesoscale and beyond.

"Proton Radiography for Materials: Mesoscale and Beyond" featured talks and panel discussions by researchers from Los Alamos, other national laboratories, and academia and industry from the United States and abroad. More than 80 people participated in the open sessions in Santa Fe. Attendees also had the opportunity to tour pRad at the Los Alamos Neutron Science Center (LANSCE), participate in a hands-on data analysis tutorial, and join a classified session.

The workshop aimed to

- broadcast the types of materials science experiments possible using pRad,
- determine materials science questions to resolve using proton radiography,
- increase the breadth of materials science performed at the pRad facility, and
- identify technical developments for pRad to address national security questions and strategic investments to benefit materials science and national security projects.

The workshop covered topics ranging from current and future pRad capability enhancements to the potential of using proton radiography to study chemical reactions, slow mesoscale phenomena, bio-imaging, and projectile/armor science.

The event was organized by Dale Tupa (Subatomic Physics, P-25) and Anna Llobet (Neutron Science and Technology, P-23). Additional organizing committee members were Andy Saunders (Subatomic Physics, P-25), Saryu Fensin (Materials and Science in Radiation and Dynamics Extremes, MST-8), and Amy Clarke (Colorado School of Mines). Logistical support was provided by Lucy Maestas (Associate Directorate for Experimental Physical Sciences, ADEPS). The workshop was funded with Los Alamos National Laboratory institutional funding.

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Workshop cont.

The Lab's pRad Facility is a dual-use facility that users can access for classified and unclassified research. This user program provides a pool of scientific talent for recruitment into the national weapons program.

The Lab's invention of lens-focused charged particle radiography, which uses a high-energy proton beam provided by the LANSCE accelerator to image materials driven by high explosives, is the direct result of the synergy between the Laboratory's defense mission and basic science research. The technique supports the Laboratory's national security science mission and provides for fundamental science discoveries.

Technical contact: Dale Tupa

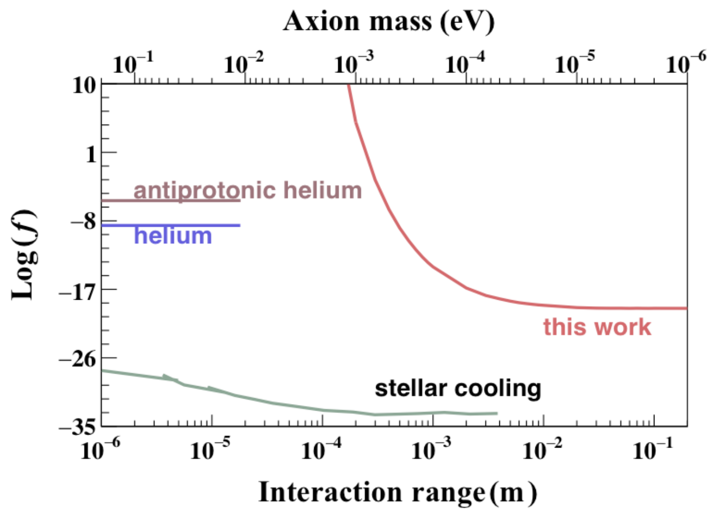
New approach sets first-ever experimental limit essential for developing new directions in axion searches

Physics Division researchers have developed a new experimental approach to searching for axions, subatomic particles whose existence would aid in understanding the matter–antimatter asymmetry of the universe and reveal new phenomena beyond the Standard Model of particle physics. Their work, which was published as a letter in *Physical Review Letters*, sheds light on the new direction of axion searches.

Current axion-searching experiments mainly focus on the axion coupling to the photon. However, a new focus of research is exotic spin-dependent interactions associated with axions. Physics Division researchers have expanded this area of research to investigate exotic spin-dependent interactions for polarized electrons using a high-sensitivity spin-exchange relaxation-free (SERF) atomic magnetometer.

Unlike existing experiments, the magnetometer in this approach served as both a source of polarized electrons and a magnetic-field sensor. In the SERF magnetometer, a weak external magnetic field tilts the SERF polarized electron spins in a vapor cell by a small angle proportional to the field's strength, which is measured with a probe laser beam. Similarly, the effective magnetic field from exotic interactions can tilt the spins, which can be detected in the magnetometer. A simple mass moving next to the SERF vapor cell could induce a new force if axions mediate the interaction between atoms of the mass and the SERF polarized electrons. Such an experiment could be conducted on a tabletop.

The team showed an experimental limit on an exotic spin- and velocity-dependent interaction between SERF polarized electrons and unpolarized nucleons, free of systematic signals, in the axion mass of 10^{-6}–10^{-3} eV. This result was within the important axion window. The team experimentally



Experimental limit on the coupling strength *f* of the exotic spin- and velocity-dependent interaction: the red curve shows the experimental limit of the team's work on the interaction between polarized SERF electrons and unpolarized $Bi_4Ge_3O_{12}$ nucleons as a function of the interaction range and the axion mass with the 82 h of data collection time.

The coupling is the combination of the scalar electron coupling and the scalar nucleon coupling. The curve of stellar cooling combines the scalar electron coupling derived from stellar cooling and the scalar nucleon coupling derived from short-range gravity experiments.

The figure also shows results from the measurement of helium fine-structure spectroscopy of the scalar electron and scalar electron couplings and antiprotonic helium spectroscopy of the scalar electron coupling and the scalar antiproton coupling.

constrained the interaction in this mass range for the first time, opening up new ranges of searches for axion-mediated exotic interactions. Although no signal from axions for the interaction was detected, the team plans to continue probing other possible exotic interactions.

The work was funded by the Laboratory Directed Research and Development program and supports the Laboratory's Global Security mission area and Nuclear and Particle Futures science pillar by aiding the development of expertise and capabilities required for its national security science missions.

Researchers: Young Jin Kim (Applied Modern Physics, P-21), Ping-Han Chu (Neutron Science and Technology, P-23), and Igor Savukov (P-21). Reference: "Experimental constraint on an exotic spin- and velocity-dependent interaction in the sub-meV range of axion mass with a spin-exchange relaxation-free magnetometer," *Phys. Rev. Lett.* **121**, 091802 (2018).

Technical contact: Young Jin Kim

Newly developed MVTX telescope collects first data for planned DOE flagship physics experiment

Working at Fermi National Accelerator Laboratory, a research team headed by members of Subatomic Physics (P-25) performed the first test of a prototype detector, proving that this state-of-the-art technology could collect data on high-energy, heavy-ion collisions. The team developed the MVTX (for monolithic active pixel sensor [MAPS]-based vertex detector) to better identify origin vertices of particle tracks for sPHENIX, a planned DOE flagship experiment in nuclear physics.

sPHENIX is proposed to study the nature of subatomic particles known as quark gluon plasma (QGP). QGP was the universe's dominant material in the first few microseconds after the Big Bang. Better understanding of it could help explain how the universe was created and improve cosmology research.

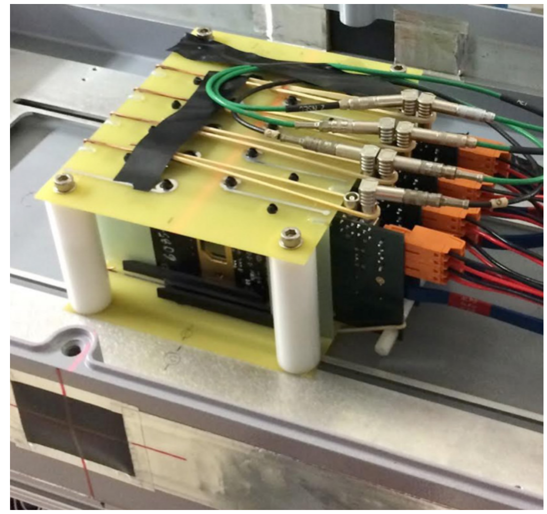
Because QGP only exists for short periods and only at extremely high temperatures and densities, it has proven difficult to measure. sPHENIX will address this challenge by providing world-class, large-scale capabilities for future multi-scale QGP studies. sPHENIX, which is planned for Brookhaven National Laboratory's Relativistic Heavy Ion Collider (RHIC), will use fully reconstructed jets and high-precision upsilon spectroscopy at high beam-collision rates to make unprecedented measurements.

The MVTX adds a key capability to this suite—it can identify jets containing heavy subatomic particles called bottom quarks. A particle tracker with unique vertex resolution and high-rate capability is required to distinguish heavy-flavor jets from the other particles produced in heavy ion collisions. Los Alamos researchers proposed the MVTX as a high-speed, large-acceptance precision vertex detector that would help sPHENIX measure bottom quarks, which in turn are precision diagnostics for the QGP. The effort combines high-level physics and technical capabilities to provide important data inputs for the full sPHENIX program.

The Laboratory Directed Research and Development program funds the prototype detector's development. The work supports the Lab's fundamental science mission and the Nuclear and Particle Futures science pillar by developing expertise and capabilities required for national security science missions. Through MVTX's development the Lab leads a major scientific activity at the forefront of international high-energy, heavy ion research.

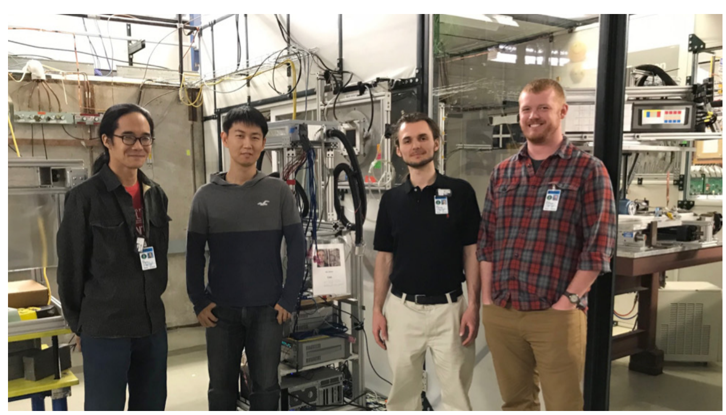
The MVTX's development for sPHENIX is only one of many potential uses for MAPS-based technology. Lab staff are exploring the technology for programs such as the one at the future Electron-Ion-Collider facility at Brookhaven. The technology may also have applications in the high-precision imaging work proposed as part of the Dynamic Mesoscale Materials Science Capability, the project formerly known as MaRIE.

Four MAPS sensors, located inside the telescope box, are stacked in the path of the beam.



Researchers: Hubert van Hecke, Chris O'Shaughnessy, Walt Sondheim, Alex Tkatchev, Sho Uemura, Sanghoon Lim, Darren McGlinchey, Xuan Li, Pat McGaughey, Kun Liu, Cesar da Silva, Andi Klein, Alex Wickes, and Ming Liu (all P-25); Mark Prokop (RF Engineering, AOT-RFE); Ivan Vitev, Chris Lee, Rajan Gupta, Zhongbo Kang, Haitao Li, and Varun Vaidya (Nuclear and Particle Physics, Astrophysics, and Cosmology, T-2); Jerome Olivier Daligault (Applied Mathematics and Plasma Physics, T-5); and Boram Yoon (Applied Computer Science, CCS-7).

Technical contact: Ming Liu



Los Alamos researchers (from left to right) Sho Uemura, Sanghoon Lim, Alex Tkatchev, and Darren McGlinchey photographed in front of the MVTX telescope at Fermilab.

HeadsUP!

Physics team wins LANL 2018 Pollution Prevention Award

Experimental system will reduce greenhouse gas emissions

A team from Plasma Physics (P-24) has received a 2018 Pollution Prevention Award, a special category of LANL's Patricia E. Gallagher Environmental Awards, for the project "Sulfur Hexafluoride-Free High-Energy Pulsed Power Systems." Team members are Thomas Weber (P-24), Colin Adams and Ian Bean (P-24 and Virginia Tech) and Michael Sherburne (Virginia Tech).

Sulfur-hexafluoride (SF6) is a potent greenhouse gas. Typically released in small amounts, these long-lived gases have a large climate impact—accounting for approximately 3% of the U.S. carbon-equivalent greenhouse gas emissions. SF6 is used throughout the DOE and private industry, primarily in high-voltage insulation and switching applications.

The P-24 team is testing SF6-free systems that use compressed air insulated plasma switches and recyclable oil insulation for high-voltage, high-current pulsed power systems that would replace legacy SF6 and mercury switches, SF6-filled transmission lines, and problematic air and vacuum insulated relays. The testbed for these systems is the Magnetized Shock Experiment (MSX) in P-24; MSX is composed of several different pulsed power systems of various voltages, currents, pulse energies, and technology bases, all of which will eventually be replaced by a single, repeated, proven design. After iterating on charging/dumping/relay/HV-sensing designs, the team has a working single pulsed power system with a tested compressed air switch and oil-insulated transmission line header to 100 kV DC. The next step is pulsed discharge testing and final design and testing of the triggering system. The team will integrate the components into a complete single capacitor bank system and then test multiple systems combined that will be used in the MSX lab.

The development of SF6-free systems to replace high-voltage insulation and switching applications will contribute to the reduction of SF6 release from Laboratory operations. Once proven, the SF6-free design could replace similar systems not only across the Laboratory and the DOE complex, but also across industry.

The Patricia E. Gallagher Environmental Awards recognize exemplary achievement in waste reduction, improved waste management, innovation that leads to environmental improvement, and environmental education. The late Pat Gallagher—a group leader in Environmental Protection and Compliance—committed her career to pollution prevention, waste minimization, and sustainability and was posthumously awarded with the 2018 Department of Energy Sustainability Award for Sustainability Champion.

Technical contact: Thom Weber

Celebrating service

Congratulations to the following Physics Division employees celebrating recent service anniversaries:

Walter Sondheim, P-25	40 years
Russell Mortensen, P-24	30 years
Thomas Murphy, P-24	30 years
Dale Tupa, P-25	30 years
Todd Haines, P-23	25 years
David Oro, P-23	25 years
Jeff Wang, P-25	20 years
Steve Clayton, P-25	10 years
Kelly Knickerbocker, P-27	10 years
John Charonko, P-23	5 years
Mandie Gehring, P-23	5 years
Michale Malone, P-21	5 years
Elizabeth Merritt, P-24	5 years

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